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Customer Purchase Behavior Prediction and Analysis based on CRM Data Analysis Technology

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Abstract: **Since e-commerce began to be widely used in many industries in China, the traditional methods of customers' purchasing behavior prediction in enterprises cannot meet the current intelligent forecasting with different network characteristics. Therefore, the CRM customer relationship management system based on artificial neural network algorithm is gradually applied to the network business of many enterprises in our country. This paper studies the application of artificial neural network algorithm in the data analysis of CRM system, and has proposed the data analysis technology based on CRM system. This technology can be used to predict and analyze the customer's purchasing behavior through the management of customer's relevant information. Finally, the experimental results show that the CRM system based on artificial neural network algorithm can efficiently predict the customers with purchasing demand through intelligent data analysis technology. Intelligent multiple prediction and analysis are carried out to achieve a new breakthrough in the technology of customers' purchasing behavior prediction in China.**

Keywords: Artificial Neural Network; Forecast of Purchasing Behavior Demand; Model.

I. INTRODUCTION

How to predict the customer's purchasing demand gradually become the key research direction and the important content of the comprehensive management of many domestic enterprises. With the increasing openness of domestic enterprises to foreign business, and the potential purchase demand of customers is also increasing gradually. How to accurately predict the purchasing demand of customers has also become a hot spot of competition among different enterprises in the same industry. At the same time, it has also posed a new challenge to the relevant technical staff of our country [1]. Therefore, how to achieve customers' purchasing demand prediction through data analysis technology based on CRM system has become an important technical barrier for Chinese enterprises to enhance their competitiveness [2]. Therefore, in order to better improve the service of the enterprise to the customers and reduce the operation cost of the enterprise, how to build a CRM system which can deeply mine the customer information has become the most important problem for enterprises in many fields (including Internet enterprises and entity enterprises) in our country [3]. In addition, there are many algorithms that can realize data mining, such as neural network algorithm, genetic algorithm, clustering analysis algorithm, differential evolutionary genetic algorithm and so on [4]. However, how to realize the analysis of information and data in the process of customer relationship management in the CRM system of enterprises is still a matter of great concern to domestic enterprises at present. Therefore, if we can construct a data analysis model based on CRM system to predict customers' purchasing behavior accurately and efficiently, it will greatly enhance the income of enterprises and reduce the operating costs of enterprises.

II. STATE OF THE ART

In the related research of enterprise CRM system, CRM system was first applied in e-commerce, which played an important role in enhancing the relationship between enterprises and customers. At present, the main researches on the prediction of CRM system and customers' purchasing behavior in the world include the traditional questionnaire method, the traditional join shop feedback method based on "pyramid hierarchical structure" and the multi-location information interaction based on Internet of things architecture etc. None of the above systems involves the customers' purchasing demand forecasting model which is based on the customer relationship information data characteristics in the enterprise CRM system. There is no foreign research on customers' purchasing behavior demand prediction of CRM system either. From the point of view of customers' purchasing behavior demand prediction in current enterprises, the author finds that these researches at home and abroad are inefficient in the traditional data search process on the one hand. On the other hand, it is impossible to analyze the relevant information of customers through modern Internet and Internet of things technology, and it is also impossible to predict the demand for customers' purchasing behavior in advance. Therefore, it is difficult to achieve the intelligent prediction effect in the historical purchasing characteristic data and the purchasing behavior demand based on the massive customer group [5]. In addition, most enterprises both at home and abroad used CRM system in the process of data analysis, have not yet developed to a very mature stage of technology. More is through the CRM system to achieve the enterprise customer information recording and classification. Therefore, the customer relationship data in CRM system is deeply mined based on artificial neural network algorithm. Thus, the prediction and analysis of customers' purchasing behavior is a development way to realize the intelligence of enterprise CRM system [6].

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III. METHODOLOGY

A. The Principle and Basic Idea of Artificial Neural Network Algorithm in CRM System in China

Artificial Neural Network (ANN) Algorithm is a kind of intelligent algorithm based on human body structure and brain ' s direct bi - directional regulation and automatic processing. When we randomly process this single neuron structure with multiple neuronal structure (synapse) features (this paper refers to the customer's historical purchasing data information in the CRM system). The mutual coupling analysis of customer data in CRM system and the vector processing analysis of multiple coupling combinations can optimize the classification of customer groups and predict customers' purchasing behavior. From the total customer group, we find out the multiple customers with high potential purchasing demand and analyze the relevant data of these customers, then classify the new generation of customers with purchasing demand characteristics through many times comparative analysis. This not only inherited the last round of intelligent screening customer information, and the degree of data analysis is better than the previous generation. After several bidirectional information data analysis cycles, the customer individuals who meet the optimal purchasing demand conditions are finally produced, and the accurate prediction of the purchasing demand of the enterprise customers is realized in a certain enterprise.

B. Establishment Conditions of Data Warehouse in CRM System Based on Artificial Neural Network

The implementation of Artificial Neural Network (ANN) for customers' purchasing behavior prediction is based on the analysis of customer data in enterprise's CRM system. Specifically, through the enterprise's CRM system in the customers' history purchasing behavior information and customers' after-sales related information to predict the future sales situation. The prejudgment process is implemented in the artificial intelligence algorithm to mine the customer's information data. In this CRM system, the artificial neural network algorithm is not in the overall customer group of the target to identify the requirements, but by the whole customer of the local customer group information data search and mining and get the optimal customer target that the purchasing demand degree accords with the predicted value. Therefore, according to the demand prediction model of purchasing behavior, big data information of historical purchasing behavior in CRM system is first used in the artificial neural network algorithm. The initial value and minimum threshold value range of required purchasing demand are determined by intelligent processing. Ultimately, you'll get the best range of searches, and then you screen out specific customers with high potential purchasing requirements. The data analysis structure of the CRM system is illustrated in Figure 1. In order to realize this process, it is necessary to establish a data warehouse in CRM system first.

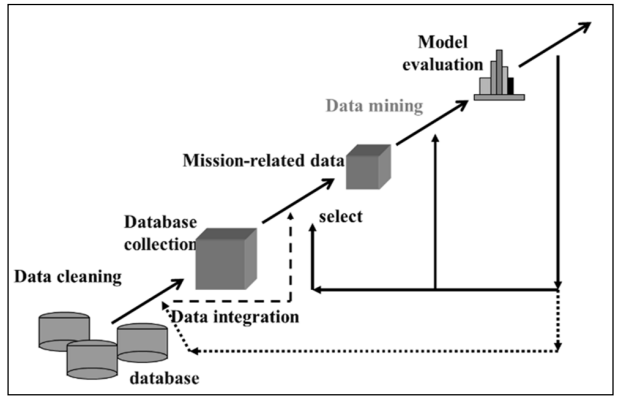

Fig.1 CRM system data analysis structure

In the traditional database used in enterprises, although the traditional database technology has efficient data storage and query functions and also supports the application of integrated management information system in dealing with customer relationships. However, these databases are mainly adapted to the needs of the related business processes of customers, and cannot carry out in-depth analysis and deep information mining for the realization of customer data. Therefore, the introduction of data warehouse to replace the traditional database can realize the intelligent data analysis and consumer behavior prediction of enterprise customers.

Before the establishment of the multidimensional Star Building Data Warehouse in CRM system model (multidimensional star model of data warehouse as shown in Figure 2), the first step needs "Appropriate Advance". It is based on the enterprise information required in the future can be predicted in advance, and consider the speculation from various aspects of the customers' buying the product and the reaction after purchasing. In this way, the preliminary data sifting can be realized, and the mining and analysis of customer information data in CRM system can be greatly reduced.

The second step requires "Design Flexibility". Briefly, it should intelligently plan and analyze the components of the customers' database and retain a certain amount of elasticity (i.e.., the space should be adjusted properly). In this way, it can meet the needs of potential customers in the future purchasing behavior changes. The purpose of this step is to prevent the process of "Extreme" analysis in CRM system based on artificial neural network algorithm when analyzing and mining the customer's information data. The second is to improve the stability and low error of the enterprise customer information data analysis in CRM system, which can ensure that the data is more persuasive.

The third step needs to meet the "Flexible Application" of CRM system. In the database established in the CRM system, we use a small database of customer information for experimental trial database. Through the continuous application of the experimental database to achieve the optimization analysis of the database, and in the daily management process to customers, the experiment database in the process of management of customers to gain experience. It also evaluates its working efficiency, improves and optimizes continuously,

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and then provides reference experience for building data warehouse, and prevents bug or other loopholes from appearing in the process of building data warehouse.

The 4th step requires "Necessary Participation". This process is to say that when building the multidimensional model of the customer data warehouse in the CRM system, we should take into account the possibility of the participation of all sectors of the enterprise, that is, the CRM system can achieve as many departments and personnel as possible. On the one hand, the purpose of this is to make the enterprise more scientific and complete in the process of collecting information from customers, and the error rate is lower. On the other hand, it can make database users fully understand the ideas of designers, so as to better serve corporate customers.

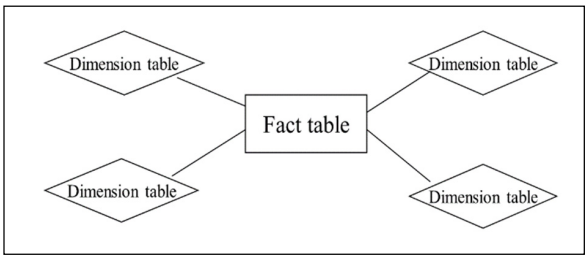

Fig.2 Customer Data Warehouse Star Model in CRM System

C. Determination of Demand Degree Function and Data Analysis Process in Artificial Neural Network Algorithm

In this CRM system, firstly, x historical purchasing behavior data from the initialized enterprise customer information data are assigned to the artificial neural network. In order to quickly realize the transmission of related customer information data input signal in multiple directions in the CRM system. Therefore, the square sum of error X_j between the output value of demand coefficient s_j and the expected value of demand $\frac{1+e^{-s_j}}{1+e^{-s_j}}$ in the forecast network of enterprise customer's purchasing demand is set as the fitness function:

$$X_j = f(s_j) = \frac{(1+e^{-s_j})y_{nj}}{1+e^{-s_j}} - w_{nj} \times \frac{e^{-s_j} y_{nj}}{1+e^{-s_j}} \tag{1}$$

Among them, y_1 to y_n is random customer group target. w_{nj} is corresponding mode.

The customer purchasing behavior prediction model uses artificial neural network algorithm to realize the self-learning of the data analysis level of CRM system. The learning process can be divided into several stages: the process of "classification of purchasing demand data", the process of "intelligent processing of purchasing demand data", the process of "forecasting and discriminating purchasing demand" and updating data auto override process. The following is a multi-layer artificial neural network as an example, based on multidimensional customer information data in CRM system to cut block process (method a three-dimensional subset is selected, the number of multidimensional) detailed description of standard artificial neural network algorithm used in the prediction of the purchasing demand. The process of clipping the customer's information data is shown in figure 3:

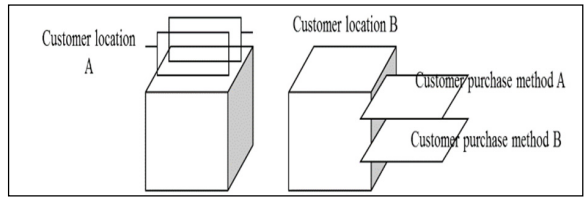

Fig.3 CRM system, the three-dimensional cube dice process of customer's information data

Taking the distance $\|\text{dist}\|$ between the input and the weight vector as the independent variable

$$R(\|dist\|) = e^{-\|dist\|^2} \tag{2}$$

The parameters to be solved by the learning algorithm include the center of the radial basis function, the variance and the weights from the hidden layer to the output layer. The expected requirement output vector corresponding to the historical purchasing data of random customers in the CRM system and the corresponding output y_j in the process are:

$$y_j = \sum_{i=1}^{h} w_{ij} \exp\left(-\frac{1}{2\sigma^2}\|x_p - c_i\|^2\right) \qquad j=1,2,\cdots,n \tag{3}$$

Set d as the expected output value of the sample, then the variance σ of the base function can be expressed as:

$$\sigma = \frac{1}{P}\sum_{j}^{m}\|d_j - y_j c_i\|^2 \tag{4}$$

$$w = \exp\left(\frac{h}{c_{\max}^2}\|x_p - c_i\|^2\right) \qquad p=1,2,\cdots,P; i=1,2,\cdots,h \tag{5}$$

The correction errors of each neuron (X_j^k and l_t^k) are calculated according to the desired output of the specified purchasing behavior prediction.

$$X_j^k = \int w_{ij} x_i^k - \theta_j \tag{6}$$

$$l_t^k = \int v_{jt} b_j^k - \gamma_t \tag{7}$$

IV. RESULT ANALYSES AND DISCUSSION

A. Experimental Test of Customers' Purchasing Behavior Prediction in CRM System Based On Neural Network Algorithm

The data information of this CRM system includes all customer information of the marketing subsystem, the sales

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subsystem and the after-sales service subsystem. The basic framework is shown in figure 4.

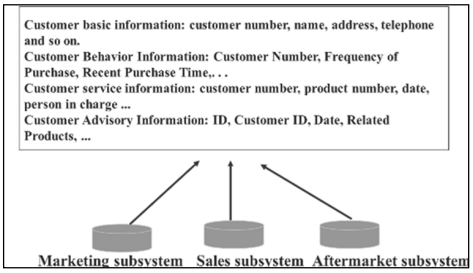

Fig.4 CRM system data information: marketing subsystem, sales subsystem and after-sales service subsystem related customer information

Through the artificial neural network algorithm and the information intelligence analysis model based on customer big data, the enterprise customer data is compared and analyzed at different levels in the customer crowd. Through the artificial neural network algorithm based on the customer purchasing behavior prediction analysis system, the first part of the customer population to receive the characteristics of the external purchasing behavior, data processing. The evaluation sample data of different customer individuals are obtained and the unique vector group data of individual clients are analyzed uniformly, and then the neural network algorithm is called. Through the initial screening and multi-angle and multi-level analysis and processing to optimize the enterprise customer correlation information, the optimal vector obtained from the optimized data in the CRM system is inversely transformed. As the optimal weight of artificial neural network and the average value of purchasing demand forecast. Then, selecting two dimensions: product dimension and regional dimension. The sales of products are sliced to realize the prediction of customers' purchasing behavior. The implementation process is shown in figure 5.

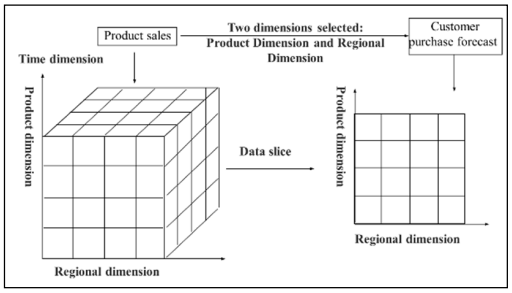

Fig.5 Prediction Analysis of Customers' Purchasing Behavior Based on Product Dimension and Regional Dimension

B. The Analysis of the Result of the Prediction and Judgment of Customers' Purchasing Demand in CRM System

In the above CRM system, the purchasing demand forecasting model adopts the processing method to test the experimental data, which is the combination of two target customers to generate the contrast processing data. Through a group of random customers of the enterprise through automatic analysis and historical purchasing information depth analysis, and synthesize a new set of purchasing behavior characteristics data. Two-way demand behavior combination generation algorithm of artificial neural network includes support parameters, it will divide the purchasing behavior data of enterprise's customers into a number of single column vector matrix based on the different demand degree. Through the comparative analysis of the different customer group weight value parameter value, plus the correlation purchase demand value to the matrix contrast analysis to ensure that the purchasing potential demand data of each customer target to realize the automatic random grouping. In this experiment, in order to make the experiment more convenient, suppose that the customers' purchasing items are: beer, diaper, baby powder, bread, umbrella, milk and coke and other items. The customer's shopping list and single-phase statistics are shown in tables 1 and 2.

Table.1: Customer test list for experiment testing

Record number	shopping list
1	Beer, diaper, baby powder, bread, umbrella
2	Diapers, baby powder
3	Beer, diaper, milk
4	Diapers, beer, washing powder
5	Beer, milk, coke

Table.2: The individual statistical results during the experiment

Individual statistics	Support
{beer}	0.8
{diaper}	0.8
{Baby talcum powder}	0.4
{milk}	0.4

From the experiment, we can find that the result of the experiment is as follows: (where S stands for support degree; C stands for forecasting result analysis).

R2: diaper - beer, S=0.6，C＝0.6 / 0.8＝＝0.75;

R3: milk - beer, S=0.4，C＝0.4 / 0.4＝＝1;

R4: beer - milk, S=0.4，C=0.4 / 0.8＝＝0.5;

R5: diaper - baby talcum powder, S=0.4, C＝0.4 / 0.8＝＝0.5;

R6: baby talcum powder - diaper, S=0.4, C=0.4/0.4＝＝1.

From these data, we can find that in the prediction process of a customer's purchasing behavior of these commodities, the CRM system has different possibilities to choose different products for the same customer. For example, when there are baby powder and diapers in front of the customer, the likelihood of the customer buying the two items is almost 1 (including a certain standard experimental error). This explains to the customer, the different commodity arrangement will affect the customer's purchasing behavior.

V.CONCLUSION

If the enterprise can improve the forecasting effect on the customer's purchasing behavior, it will play a great role in the

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enterprise's increase of profit and reduction of operation cost. This paper first reviews the current research and classification of Chinese enterprises' demand forecasting methods for customers' purchasing behavior. The research status of customers' potential purchasing demand prediction and the existing problems of CRM system are discussed. Then a prediction model for customers' purchasing behavior is proposed, which is based on the artificial neural network algorithm in the CRM system to analyze customer information data. Finally, the prediction effect of the model on customers' purchasing behavior is tested by experiments. The experimental results show that the model based on artificial neural network algorithm can quickly determine whether the customer has a potential purchasing demand problem. Through the experiment on two kinds of different buying behavior subjects (i.e. customer) conducted a comparative analysis experiment, finding that the purchasing demand of customers in the system can be predicted, the purchasing behavior needs of small customers were the model of "detained", so as to better guide the better customer service enterprises. The error is within a stable standard reference range. The accuracy of the error indicates that the prediction model in this CRM system can be used to predict the customers' purchasing behavior of many enterprises. In addition, the current development of domestic and foreign enterprises, especially in the supply side of the imbalance phenomenon, it will also make the prediction model of customers' purchasing behavior based on artificial neural network have a better application prospect, so as to replace the traditional model of customers' purchasing behavior analysis and prediction based on artificial neural network. Although there are some deficiencies in the current customer purchase demand prediction technology and related algorithms, the prediction model and related algorithm technology are used in the daily use of Chinese enterprises. In theory, it can satisfy the daily purchasing behavior forecast of customers, and it can reduce the operating cost and improve the profitability of the enterprise.

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